GLUED AND NAILED ROOF TRUSSES FOR HOUSE CONSTRUCTION

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GLUED AND NAILED ROOF TRUSSES FOR HOUSE CONSTRUCTION

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Introduction

To simplify house construction and thereby to save on costs, the use of lightweight roof trusses is becoming a standard practice. By using lightweight trusses, the exterior walls and roof can be erected without the placement of any interior partitions. Thus the interior becomes one big workshop. The entire ceiling and walls can be finished as one unit without interruption by partitions. If dry-wall construction is used, it means that sheets as large as 4 by 12 feet can be placed without any cutting. Similarly, the finish floor can be laid over the entire area without the cutting and fitting necessary when partitions are in place.

By such construction interior partitions can be moved without affecting the structural stability of the house; thus any floor plan can be changed at any time to meet changed living requirements. Also, since no bearing partitions are necessary, large unobstructed areas, in conformity with the present trend toward open planning, are more easily obtained.

The lightweight roof trusses now in rather common use are of nailed construction. When of adequate design and well manufactured, they are giving good service. The question has, however, been repeatedly raised as to whether glued trusses would not give better service; possibly with some saving in material.

It is known that a well-made glue joint will withstand a very high load immediately after manufacture. It is not, however, known how such glued

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[1]Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

joints in a truss will withstand the stresses caused by the shrinking and swelling of the component parts of a truss under service conditions. The shrinking and swelling, caused by changes in the moisture content of the wood, may be very considerable where large changes in relative humidity occur. This is likely, for example, in attics that are not well ventilated and where an inadequate or no vapor barrier is placed in the ceiling. Therefore the Forest Products Laboratory has been making an investigation to obtain information on the relative merits of nailed and glued light roof trusses under simulated service conditions.

Construction of Trusses

The trusses tested were of the "W" type. The full length of each truss was 17 feet 6 inches, and it was tested over a span of 17 feet. The distance between the panel points of the lower chord was one-third of the span, and the joint in the upper chord was at the midlength of the chord. The slope of the upper chord was 5 in 12. The trusses were shorter than usual in house construction, but they were the maximum length of a truss that could be placed in the conditioning room available at the Laboratory.

The material was high-grade Douglas-fir at a moisture content of about 12 percent. High-grade material was used to insure failure at the joints. The material for the upper and lower chords, as well as for the diagonals, was nominal 2- by 4-inch stock, the net sizes being 1-5/8 by 3-5/8 inches. Plywood gusset plates were used for all of the panels. This plywood was exterior-type Douglas-fir.

The nails used were ninepenny common of sufficient length (2-3/4 inches) to extend through both gusset plates and the central member. This type of nailing was used because it is more economical than nailing from both sides of the truss.

The glued trusses employed considerably smaller gusset plates than the nailed trusses. A resorcinol type of glue was used to eliminate the possibility of glue failures during subsequent exposure of certain panels to high and low humidities. Pressure was obtained by clamps during the setting of the glue.

Service Condition

In service some drying and shrinking normally take place, causing a separation of the several parts of a nailed joint. This lowers the strength of a nailed joint, since there is no friction to overcome. To simulate service conditions, a 0.027-inch-thick spacer was placed between gusset plates and the central member during nailing, thus creating a separation of 0.027 inch between the parts.

Prior to test one nailed and two glued trusses were subjected to high and low humidities. One cycle consisted of exposing the trusses to 80 percent relative humidity for 30 days and then to a relative humidity of 20 percent for 30 days. This complete cycle was then repeated, and the trusses were tested immediately after removal from the kiln. During the conditioning period the panels were loaded to a design load equal to a roof load of approximately 35 pounds per square foot and to a ceiling load of 10 pounds per square foot.

Testing

All panels were tested in bending by dead load. The upper chord of the truss was first loaded to a design load of 1,200 pounds, which is equivalent to a roof load of 35 pounds per square foot. In addition, the lower chord was loaded with six 50-pound weights placed at the quarter points between panel joints, which approximated a ceiling load of 10 pounds per square foot. After this loading the roof load was removed and residual deflections were read. The ceiling load was left on the truss during the entire testing. The roof load was then increased to approximately 2-1/4 times the design load, or to a load of 2,800 pounds. This load was then removed, and the residual deflection measured. Roof loads were then applied until failure occurred. Loading was in 200-pound increments up to the design load, and then the load increment was increased to 400 pounds.

Resume

1. Well-designed and constructed nailed trusses should give adequate service.

2. Glued trusses, because of the rigid joints, are much stiffer than nailed trusses.

3. Glued trusses fail without warning, whereas nailed trusses will deflect considerably when approaching failure with little increase in load.

4. Glued trusses show some loss in stiffness and considerable loss in maximum load from exposure to low and high humidities. The same exposure reduced the stiffness of nailed trusses up to and slightly beyond design load, but with no loss in maximum load.

5. Even after exposure to low and high humidities, glued trusses deflect less at design loads than unexposed nailed trusses.

6. Although the glued trusses showed considerable reduction in maximum load from high- and low-humidity exposures, the failing load was still several times design load.

General Discussion

It is well established that a glued joint is much stiffer than a nailed joint. Where low deflection is of importance -- for example, in the lower chord of a truss that forms the framing for a ceiling -- a glued truss may be of considerable advantage. It has a further advantage in that there would be less risk of racking a glued than a nailed truss out of shape during transportation and erection. In the manufacture of a glued truss it is, of course, necessary to have pressure on the joint during the setting of the glue. This pressure can be obtained through a press, by clamps, or with nails. In the manufacture of the glued trusses just discussed, clamps were used for obtaining pressure. It would have been much easier to have used nails for obtaining the necessary pressure, but then the question might have been raised whether the efficiency of the glued joints was assisted by the nails.

In commercial production a nailed, glued truss might be the most economical to produce because nails are a simple and cheap method of obtaining pressure on the glue joints during the setting of the glue. The glued joints would certainly produce a truss with low deflection under load. In addition, the nailing would have a psychological value in reassuring those who doubt the adequacy of a glued jointed truss under large changes in humidity.